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Turbulent flashes

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With 2 figures in the text

When a liquid flows through a tube there might appear turbulent flashes in the flow as a result of collapses of toroidal entry disturbance vortices after travelling certain distances of accumulation downstream of the tube inlet from where they emanate (see further E. Rune Lindgren: Arkiv för fysik *12*, pp. 1–169, 1957).

Lindgren supposes (p. 59) that these flashes principally should have the features of toroidal whirls, like figure 1, disturbed by smaller whirls. He proposes, moreover, that the flash rolls up the surface layer of the liquid in contact with the tube surfaces. I have discussed the matter with Lindgren. We have arrived at the conclusion, that this description of the turbulent flash is not quite correct.

For the sake of simplicity I will confine myself to Reynolds numbers R between 2000 and 2400, where $R = U d/\nu$, (U = mean flow velocity, d = tube diameter and ν = kinematic viscosity). Then, according to Lindgren's experiments (pp. 92 and 128), the flashes proceed with velocities between 100 and 90 % of the mean flow velocity without changing their lengths. These flashes have a length of about 15–20 tube diameters. (The diameters of the experiment tubes varied from 6 to 12

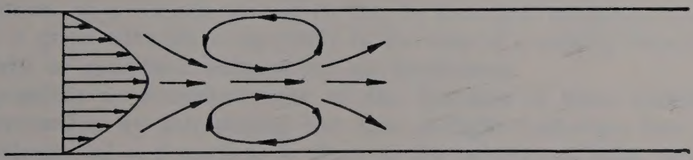

Figure 1. Average velocity components of a toroidal whirl, which may occur in this shape as an entrance disturbance.

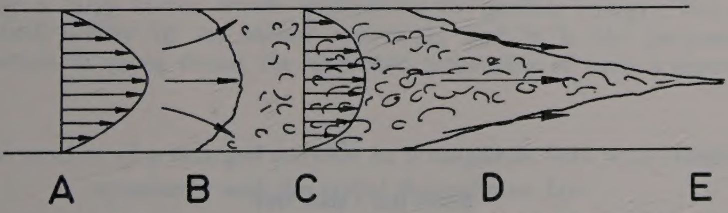

Figure 2. Average velocity components at the fore and aft ends of a turbulent flash, which is not drawn with correct relative dimensions.

mm.) The turbulent flashes are characterized by their pointed front and more or less hollow tail, see figure 2.

Since the traversed distance of the flashes in the actual cases is up to about 11 metres and since the flow between the flashes has an almost perfect laminar velocity distribution (J. Rotta, Ing. Archiv 24, p. 258, 1956) it occurs that under the circumstances quoted, up to one metre "length" of laminar flow enters the aft end of the turbulent flashes and becomes turbulent while the same volume emerges from the fore end of the flash and again becomes laminar (Lindgren, pp. 98, 102, 148).

It is natural to suppose the velocity profiles of the turbulent flashes to be more flattened than the velocity profiles in the laminar intervals, as indicated at the sections A and C in figure 2. Therefore, some part of the flow at section B, somewhere between sections A and C must have velocity components directed obliquely outwards, and in the same manner velocity components of the flow must be directed obliquely inwards somewhere around section D, between section C and the fore end E of the flash.

Thus we see that the average velocity distribution of a turbulent flash cannot properly be described as being a toroidal whirl in its classical meaning as sketched in figure 1.

This state of affairs indicates that transition from entrance disturbance vortices to turbulent flashes, among other things, implies a change of the main rotational direction of the disturbance.

Dr Lindgren intends to do further experimental work in the laboratories of The Royal Institute of Technology in Stockholm in order to investigate the above inference from his earlier measurements.

Royal Institute of Technology, Stockholm 70, August 23, 1957.

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